Remote sensing of planetary atmospheric particulate with polarized inelastic scattering

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The quantification of rotational Raman scattering (RRS) in planetary atmospheres and the in-filling of gaseous absorbing lines, such as the oxygen A-band (758–772 nm), by inelastically scattered photons is investigated with the vector radiative transfer model SCIATRAN [1]. For various viewing geometries, instrumental specifications and geophysical scenarios, we show that changes in total upwelling radiance, RRS and light polarization help in the retrieval of dust-like aerosol and ice cloud properties. This can be already demonstrated for fictitious measurements of the upcoming ESA Sentinel-4 geostationary mission on board the Meteosat Third Generation Sounder (MTG-S) satellite, whose launch is scheduled for 2020. Sentinel-4's payload is the imaging spectrometer Ultra-violet/Visible/Near-Infrared (UVN) that covers the oxygen A-band at a nominal spectral resolution of 0.12 nm and monitors Europe with hourly time sampling.

From the perspective of algorithm refinement striving higher accuracy of trace gases inference from the UV, the magnitude of inelastic radiation calls for the incorporation of RRS, or development of mitigation strategies for it, in retrieval algorithms of aerosol and cloud products from absorption bands, as the magnitude of RRS-induced scattered light is not negligible anymore. This is especially true for modern chained L1-to-L2 processors, whose geophysical outputs increasingly rely on a common description of the microphysics of scattering particulate across the full spectrum. Moreover, it can be shown, as proof of concept, that the RRS technique developed for Sentinel-4 [1], can be applied to observable quantities of exoplanets such as the spectral geometric albedo [2]. The addition of polarimetry to rotational Raman spectrometry, applied to the characterization of exoplanets, has not yet been foreseen as the spectral requirements (e.g. resolving power and signal-to-noise) impose a demanding technological maturity and size of receiving optics and spacecraft. However, we believe that the information concealed in the spectral signature of Raman scattering (the so-called Raman ghosts [3]) together with polarization make feasible the detection of suspended particulate in exoplanetary atmospheres.

References

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